§2. Design of Collection Optics for LHD Thomson Scattering System

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A spherical mirror will be used for collecting scattered light, because of its resistance to intense neutron flux and its low price compared with lens system. In designing the system, important concerns are: (1) solid angle, (2) aberration, (3) scattering length and (4) coupling to the optical fibers which transmit the light to polychromators. Since the scattering direction is almost backwards as shown in Fig.2 in the previous section, the angle of image with respect to the optical axis is small. For the fibers to accept the incident light efficiently, this angle must be greater than 30 degree. Although smaller magnification will cause this angle larger, this introduces larger aberrations which in turn drops the coupling to the fibers. Thus we must optimize the parameters so that they give the best performance in terms of the light collection power and the spatial resolution(scattering length). Fig.1 shows an example of calculation. If we can make the diameter of laser beams in the plasma less than 3 mm, most of the collected light will be coupled to the fibers of 2mm in diameter. For the present example, the image length is 25 cm and only 120 fibers will be arrayed. To raise this channel number, a new fiber coupling method is under consideration.

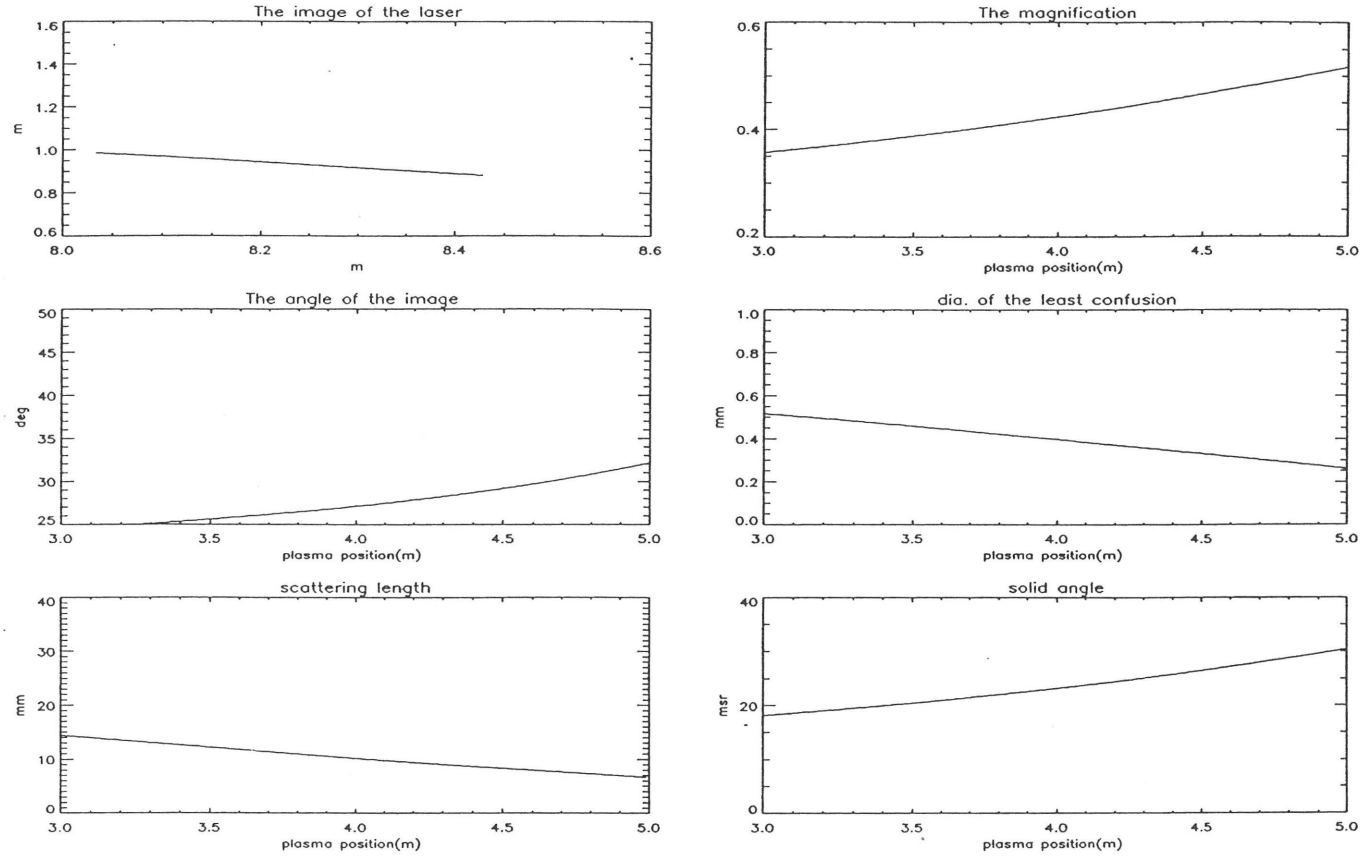

Fig.1. The locus of the image , the magnification, the angle of the image with respect to the optical axis, the diameter of the least confusion, the scattering length and the solid angle as a function of the position in the plasma (major radius) for the mirror diameter D=1.2m and the radius of the mirror curvature R=3.5 m.